Weatherwise

Probing the Thunderstorm

American Meteorological Society

A Recent Meteorological Rocket

That Summer of 1816

The Tornado Story of 1948

Lightning Flash!

Vol. 1, No. 3
JUNE, 1948

"SOME PEOPLE ARE WEATHERWISE BUT MOST ARE OTHERWISE" — BENJAMIN FRANKLIN

WEATHERWISE

THE MAGAZINE ABOUT WEATHER

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LETTERS TO THE EDITOR

Sir:

Having spent a full year building and operating the Little America weather station, I was very interested in the report in the April issue of the formation there of an Antarctic Branch of the American Meteorological Society. Its first meeting was exactly seven years and three days after I closed the station.

The rapid growth of meteorology and the AMS in recent years is readily seen from this contrast: On our full-fledged expedition of 1939-41 there were only two meteorologists and AMS members. One was Herbert G. Dorsey, Jr. (now Capt. Dorsey), meteorologist at East Base south of Cape Horn, and I was at Little America, 1,600 miles away. Now a short summer voyage has enough meteorologists to form a branch of the society with 14 members.

The cover picture, however, bothered me until I found it had been reversed, left to right. Viewed in a mirror, the picture looks quite familiar. The thermometer shelter is stored in the doorway to the balloon house; the pibal plotting board is in place, and the barometer case is ready for another barometer. I hope that weather maps transmitted by the same radiophoto system are not similarly reversed.

ARNOLD COURT
1901 23rd St., S. E.
Washington 20, D. C.

ED. NOTE: The April cover was made from the first received of several Navy radiophoto prints, some of which are mirror images of the others.

Sir:

A. C. Hawkins wrote me that a radio commentator reported that on August 12, 1947, at Pennsburg, Pa., pictures were etched into glass by lightning.

I wonder if anyone else has noticed this. If the picture were a photographic print (silver) in contact with glass in a frame, the lightning would pass more readily through the portions more heavily of silver (dark parts) and might well vaporize some of it. The silver would then condense on the glass into a picture that might be described as "etched" on the glass. True etching might result from melting of the glass surface where lightning shone through thinner parts of the picture. More likely, it didn't happen, or else the so-called etching was merely a dendritic path of a discharge.

CHARLES F. BROOKS
Blue Hill Meteorological Observatory
Milton, Mass.

Sir:

It may interest your readers to know about a pibal I made here when a small tornado passed southeast of us during May, 1930. The twister swirled downward from a cloud base of at least 1,500 feet with the funnel end whipping about considerably. Our airport winds shifted to the west-northwest with a velocity of 65 miles per hour. After the storm was sighted, I turned the balloon out of doors and was able to observe it as it began to enter the funnel. It curved spirally

(Continued on page 60)

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Cover: Three Air Force P-61 Black Widow night fighters are silhouetted against a thunderhead as they fly in formation before separating to penetrate a thunderstorm at three different levels, each 5,000 feet above the other. (See page 47.)

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General, circulation, and advertising offices: Franklin Institute, Philadelphia 3, Pa. Articles and pictures are welcome, but unsolicited manuscripts must have return postage provided by the author.

This thundercloud was photographed from the Naval Air Station, Hutchinson, Kansas, at about 8:30 p.m., May 27, 1945. An airplane was flown about 30 miles east-southeast toward the storm, which was probably another 20 miles away. Its base was estimated to be at 4,000 feet; the top at 25,000 feet; freezing level at 16,000 feet, from surrounding raobs. A brilliant lightning display was seen within the cloud after nightfall.

Probing the Thunderstorm

HORACE R. BYERS, U. S. WEATHER BUREAU THUNDERSTORM PROJECT AND THE UNIVERSITY OF CHICAGO

WHAT MAKES IT TICK? That same question which prompts the small boy to take apart the alarm clock also motivates meteorologists to study the intricacies of complicated atmospheric storm structures. Most spectacular and the most challenging to the everyday weatherman is the thunderstorm. It is regarded by many as the greatest remaining single hazard to aviation. It accounts for serious lightning damage, produces flash floods, storm winds which sometimes become tornadoes and holds all men in awe of its might. Small wonder that man's insatiable curiosity, exemplified by Benjamin Franklin's interest in lightning, has led him to seek knowledge about the inner workings of this meteorological monster.

For years the thunderstorm meant almost certain death to those who tried to probe it with manned balloons and airplanes. Finally, in the last decade have emerged apparatus and techniques for instrument flying which have made it possible, although still somewhat dangerous, for man to project himself and his airborne instruments into the heart of a thunderstorm. The importance of radar in controlling airplanes on these hazardous missions and in echoing the exact locations, outlines and motions of the storms can hardly be overemphasized.

Following a series of accidents to commercial and military airplanes in thunderstorms, the United States government just before the close of the war determined to investigate these storms by making use of recently developed equipment and techniques. Under the joint auspices of the Weather Bureau, the Army Air Forces, the National Advisory Committee for Aeronautics, and the U. S. Navy, the Thunderstorm Project was

organized during the fall and winter of 1945 so as to be ready for investigations in the 1946 thunderstorm season. The general direction of the project was placed in the hands of the Weather Bureau.

During the first season operations were in the vicinity of Orlando, Florida. This is in the region of maximum frequency of summer thunderstorms, and abundant opportunity was afforded to study storms in an almost tropical location. For the following summer, 1947, all equipment and personnel were moved to southwestern Ohio where operations were carried on from the All-Weather Flying Center at Wilmington, Ohio. Data were then obtained for a variety of thunderstorm types. Both at Orlando and Wilmington the Air Forces were host to the project and provided vital services, especially all airplanes and radar equipment used in the work.

In these investigations the thunderstorm was attacked from several angles. Actually, there were four main parts to the observation program: 1. airplanes; 2. swarms of balloons (rasondes and rawinsondes); 3. a surface micronetwork; 4. radar.

The airplanes used were P-61 Black Widow night fighters. Five airplanes stacked at 5,000-foot intervals from 5,000 to 25,000 feet made simultaneous passes through the selected thunderstorms. They were equipped to record on film the data of special instruments for measuring the extent and speed of updrafts and downdrafts, in addition to the smaller-scale turbulence and accelerations encountered in the storms. These instruments and the technique for the measurements were developed and operated by the personnel of the Aircraft Loads Division, Langley Memorial Laboratory of the National Advisory Committee for Aeronautics. These records provided the principal information concerning the vertical air currents present in thunderstorms. The airplanes also carried instruments for measuring temperature and electrical field, and were equipped with radar. Visual observations were taken by the pilot and radar operator, and in the 1947 season in Ohio a weather observer also formed part of the crew.

The balloons gave additional details of thunderstorm structure and circulation. At 10 points on the ground in an area about 12 by 24 miles in Ohio and about half that size in Florida upper-air stations were established. Six of them were rawinsonde stations, operated with radio direction-finding on the rasonde with SCR-658 ground equipment. The remaining four were radar balloon stations (SCR-584) used for radar tracking of balloons with ordinary radar targets. By plotting the courses of three or more balloons ascending simultaneously at various points on the outskirts of the thunderstorms, the horizontal inflow or outflow could be measured. Thus the vertical circulation could be obtained by the airplanes and the horizontal currents could be measured from the balloons.

The surface micronetwork consisted of 55 stations, each equipped with a sensitive self-recording rain gauge, barograph, hygrothermograph and gust-recording wind instrument.

One of the 55 self-recording stations of the Thunderstorm Project. The shelter contains a hygrothermograph and, for calibrating it, a psychrometer and fan. In the box bearing the shelter are a barograph and two wind recorders, one for direction and one for speed. A special portable Army anemometer and wind vane, not now available, were used. In the background is a Friez weighing rain gauge modified for greater sensitivity by enlarging the mouth area 2½ times.

In Florida these stations were located about one mile apart, but in Ohio a separation of two miles was deemed to be adequate and to give a larger total area of coverage. The instruments were attended daily by Weather Bureau observers who covered their assigned routes in jeeps.

Air Force long-range search radars were available for use both in Florida and in Ohio and, as a matter of fact, their existence had much to do with the selection of these localities for the observations. The radar served a twofold purpose, not only providing a complete record of thunderstorms passing within range but also tracing the airplane paths so that the flights could be controlled and, for analysis purposes, recorded at all times with respect to the exact airplane locations in relation to the cloud. For obtaining details on the vertical development of the thunderclouds, range-height indicating (RHI) radars were used. All radar presentations were automatically photographed.

More than 150 thunderstorm days were studied during the two seasons and 1,363 airplane traverses were made through thunderstorms without mishap. Nearly 40 miles of film were used and almost an equal amount of pen-and-ink records were inscribed by the instruments at the surface stations. It is difficult to visualize the prodigious amount of work necessary to reduce these data to a simple picture of the thunderstorm.

Results of Analysis

A widely accepted conception of the thunderstorm has pictured it as a column of continually rising air fed by inflowing moist currents below and compensated by an outward spreading at the top and slow sinking in the surroundings. Such a picture is in keeping with simple theories of meteorological thermodynamics but has no direct measurements to support it.

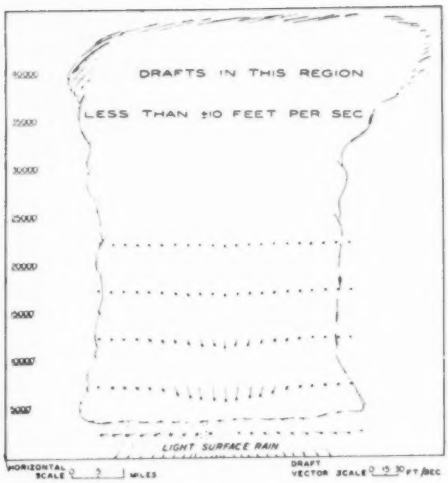
The results, which are still in the process of being analyzed, showed that this "chimney" theory of thunderstorms is untenable. This was not essentially a new discovery by the project; other meteorologists had already come up with serious doubts of the validity of this oversimplified picture. The new observations, however, have obtained fairly precisely the true picture.

Early in the analysis of the data, Roscoe

Paul Goldberg follows a rasonde balloon by means of the SCR-658 radio-direction finder.

R. Braham, Jr., Weather Bureau analyst on the Thunderstorm Project, noted that a thunderstorm seldom consists of a single cell of convection. Usually there are several cells in various stages of development, joined together. As suspected by previous workers on the subject, it was found that the structure and circulation of the thunderstorm or, more particularly, the thunderstorm cell, was different in the various stages of its development. A life cycle of a thunderstorm cell is now well established. This cycle can be described in terms of its three principal stages: cumulus stage, mature stage, and dissipating stage.

In the cumulus stage the cell has a circulation not radically different from that represented by the "chimney" theory. The winds of the surface micronet showed inflow or horizontal convergence under the cloud in this stage and the data from the airplanes showed that the only appreciable vertical displacements were updrafts. This stage, as the name implies, exists before the beginning of the rain. Upon plotting the courses of three or more balloons ascending simultaneously at various points on the outskirts of the cloud it was noted that inflow or horizontal con-



The circulation in a mature thunderstorm cell.

vergence was occurring at all heights. Air from the unsaturated surroundings apparently was being drawn into the cloud and was becoming part of it.

When rain begins to fall, the cell enters the mature stage. In the areas where the Thunderstorm Project observations were made, rain did not occur before the cloud had built up well above the freezing level, thus suggesting the possibility of the ice-crystal method of coalescence of raindrops as first outlined by Bergeron. The heights of the cloud tops were determined by radar, and the network of recording rain gauges indicated the beginning of the rain.

The most striking feature of the mature stage is the development of a large-scale downdraft in a portion of the cell where nothing but updrafts existed previously. This downdraft is directly connected with the rain; the observations invariably showed the downdraft and the rain to be associated. The downdraft originates in the middle altitudes of the cloud, probably not far from where the first snow and rain begin. Above this height, updrafts are present across the entire cloud.

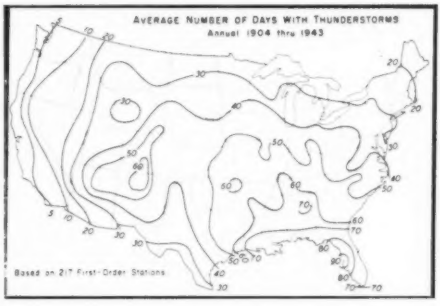
A striking characteristic of the downdraft is its spread at the surface. The micronetwork data showed that everywhere where appreciable rain was falling there was an outflow or horizontal divergence at the surface. At the same time, the balloons showed inflow aloft between about 2,500 feet and 22,000 feet. Thus, in the mature stage the cell takes in air from the surroundings and exhales it at the top and bottom.

In the anvil or dissipating stage, the entire cloud, except the topmost parts, is characterized by weak downdrafts. The descending air continues to flow outward or diverge horizontally at the surface and the rain continues until the dissipation nears completion.

Project analysts are pursuing a close study of the nature of the outflow of air from underneath the downdraft-rain area. This air is much colder than the air which it replaces at the ground. The cooling is caused in a large measure by the rain, but this cool surface air often runs ahead of the rain area. It forms a miniature cold front against the warm air outside the rain core. As suggested by G. N. Brancato and L. P. Harrison of the Weather Bureau, and others, there is evidence that this shallow pseudo cold front touches off new convective cells which contribute to the growth of the thunderstorm.

This cold, diverging layer has been studied in detail by Harry Moses, a supervising analyst of the Thunderstorm Project. He has noted the sudden increase in the wind which, within certain narrow time limits, accompanies the temperature break as the cold layer moves in. This acceleration of the wind he calls the "first gust."

Amateur weathermen might be interested in adding to the data which Mr. Moses has collected by noting the times of temperature break, beginning of rain and first gust, together with the respective values of these elements. It will be found, as many have no doubt already noted, that they do not always come exactly together.



From *Hydrometeorological Report No. 5.*

AMERICAN METEOROLOGICAL SOCIETY

NOTES ON THE 98TH NATIONAL MEETING

SIX WELL-ATTENDED SESSIONS featured the 98th national meeting of the American Meteorological Society at Washington, April 20-23, 1948. Forty-six papers represented meteorologists' research in many parts of the world. The April meeting, as usual, was held in conjunction with the meeting of the American Geophysical Union; the major session was a joint meeting with the entire Geophysical Union, while two other sessions brought together the Meteorological Section of the Union. Three sessions for papers were held independently by the AMS.

The wide range of subjects covered by the papers again emphasizes the large scope of present-day meteorological research. Of special interest to AWA members were the two symposiums devoted to forecasting: Objective Forecasting Techniques, and Long Range Weather Problems.

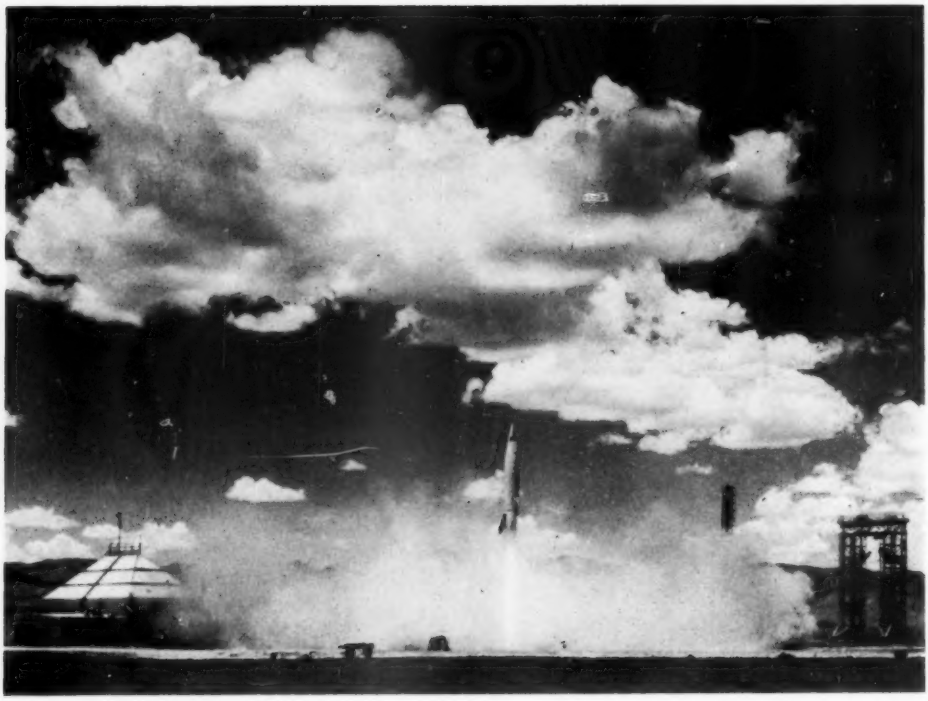
Last winter the Short Range Forecast Development Section of the U. S. Weather Bureau was founded for the specific purpose of improving the 24-36-hour forecasts, and the first symposium presented a report of the work of this group. Wayne C. Palmer outlined his method of forecasting the direction of movement of winter cyclones. By studying the recent path of a low pressure area, its current geographical location, the orientation of the axis of the low, and the normal course of such a disturbance, Mr. Palmer is able to determine the deviation (in degrees of the compass) of the low from the normal. Two other papers, by R. Robert Rapp, Conrad P. Mook and Louis Goldman, dealt with winter precipitation and ceilings at Washington National Airport. Statistical data were presented to show the developing phenomena preceding closed conditions at the airport. The work of this group has already resulted in an improvement in published newspaper forecasts at Washington.

The symposium on long range weather was keynoted by Professor H. C. Willett, Massachusetts Institute of Technology, in his discussion, "Patterns of World Weather Changes." He called attention to the many cycles of weather variations that have been identified, both in historic and geologic time. He commented on the Brueckner cycle and noted that its influence is often overlooked by the short range forecaster, with the result that the occurrences of many extremes of weather are not forecast.

The Weather Bureau's methods in preparing its long range outlooks were discussed in papers by G. W. Brier and Jerome Namias. Maps for a 40-year period have been examined and the mean pressure patterns month by month determined. Variation of the current weather map from the normal of the month forms the basis of this method. The Weather Bureau places great emphasis on the pressure pattern at 10,000 feet (700 millibars) and the customary movement from west to east of ridges and troughs in the westerly flow of air at this level. A fuller discussion of this method was presented by Mr. Namias in WEATHERWISE for April.

Another approach to the same problem, developed in the past 10 years at California Institute of Technology, was reviewed by the two men most intimately associated with the project. Dr. I. P. Krick elaborated on his use of circulation patterns in determining long range weather behavior. He lays great stress on the surface map and on the relative position of the semipermanent cells of high pressure (Hawaiian and Bermuda highs). The development northward and recession southward of these cells is directly reflected in a change in the path of lows entering North America, and this, of course, affects the general precipitation pattern over the entire country.

Also at Caltech, Professor R. D. Elliott has made a thorough study of blocking action as an initial phase in a long-period weather process. He described blocking action as the interposition of a strong cell of high pressure in the normal west-to-east path of extratropical low pressure centers. Instances of blocking highs appearing over Europe, and the subsequent movement of the blocked troughs westward over a period of weeks were illustrated with the assistance of charts. An occurrence of this nature took place late this winter and resulted in the breakup of the California drought early in March.



V-2 rocket No. 25 just leaving the ground. At this instant the missile was subjected to approximately 28 tons of thrust. The intense flame of the rocket motor is visible.

A Recent Meteorological Rocket

LT. COL. W. LOTZ AND MICHAEL FERENCE.

U. S. ARMY SIGNAL CORPS ENGINEERING LABORATORIES

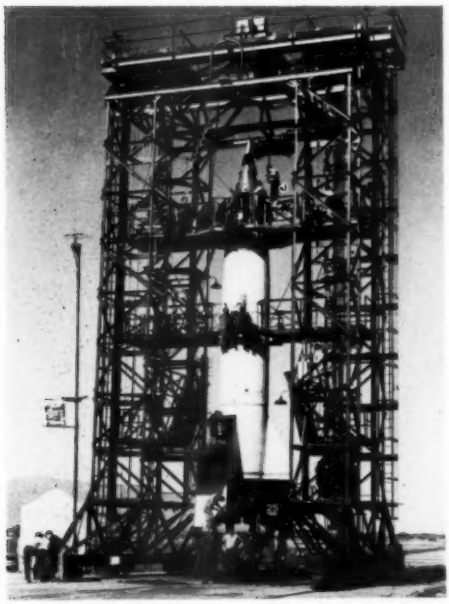
A ROCKET carrying primarily meteorological instruments for making measurements in the upper atmosphere was successfully launched on April 2, 1948, at White Sands Proving Ground, New Mexico. This V-2 was the first of a series of rockets being launched in connection with the United States Army Signal Corps upper atmosphere research program. Using rockets as vehicles to carry instruments over 40 miles above the earth, the Signal Corps is probing the little-known region of the upper stratosphere for possible clues relating tropospheric weather with various upper atmosphere phenomena.

The United States Army Ordnance Department together with the General Electric Company is rehabilitating, assembling, and launching these V-2 rockets at White Sands Proving Ground. A generous amount of space has been made available within certain designated rockets for the Signal Corps experimental equipment. Missile No. 25, the one which was fired on April 2nd, is shown in the accompanying photographs — in the process of instrumentation preparation and at the instant of firing.

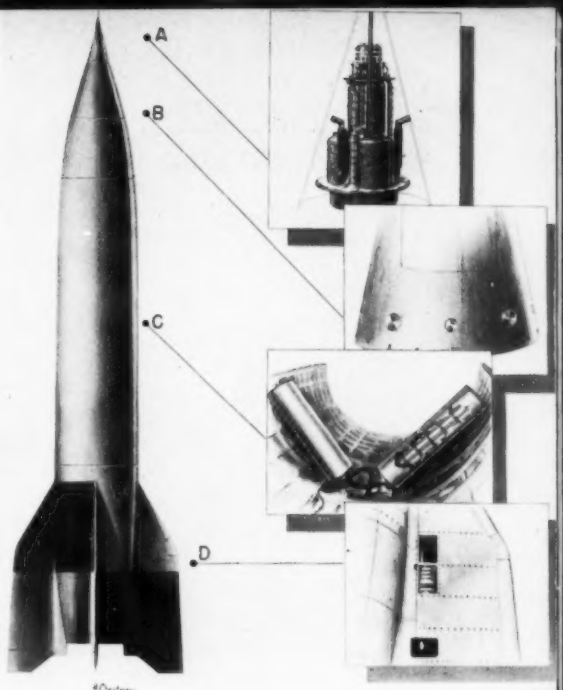
One of the most important characteristics of the upper atmosphere that requires careful and detailed study is the vertical temperature distribution. The region from 100,000 to 400,000 feet is, from the point of view of meteorology, of immediate importance. However, the problem of obtaining detailed and meaningful temperatures at these heights is indeed a difficult one. This is especially true when one realizes that the rocket is traveling

through the region with speeds three to four times the speed of sound, and that it traverses this distance in the order of 75 seconds. In the present V-2 firing two methods were used to deduce the temperature field.

The first method was based on a measurement of the velocity of sound as a function of altitude. Twelve explosive grenades, specially developed by the Picatinny Arsenal to withstand the acceleration and vibration of powered flight, were installed in tubes near the nose of the rocket. The portholes are shown in the accompanying drawing. These grenades were ejected one at a time by small charges of powder which were ignited electrically through a timing mechanism. A fuse in each grenade caused it to explode a definite number of seconds after its ejection from the rocket. The time of arrival of the sound of each explosion at the ground was recorded by an array of sensitive microphones located directly beneath the trajectory of the rocket. From measurements of these times of arrival it is possible to deduce the mean velocity of sound through well-defined layers of the atmosphere. From a knowledge of the composition of the air and the velocity of sound,



The rocket of April 2nd in the gantry being prepared for its launching.



Installations in the meteorological rocket of April 2nd. *A.* Pressure gauges installed in the nose cone. *B.* Portholes for the grenades used as sources of sound. *C.* Sampling bottles in the midsection. *D.* Cameras in the fins to determine the aspect of the rocket in flight.

the mean temperature of each layer can be computed. At the time of this writing the complete data of this firing have not been analyzed.

The second method for deducing the temperature field takes advantage of the supersonic velocities of the V-2 rocket. From wind-tunnel measurements at supersonic speeds, it has been possible to correlate the ambient temperature with the ratio of the dynamic pressure at the vertex of a 10-degree cone to the pressure around the base of such a cone. The speed of the rocket, and hence the relative speed of air, is accurately measured by radar and optical instruments.

The design and installation of all equipment necessary to perform this experiment were done by the research teams of the University of Michigan, who are scientific collaborators in the Signal Corps upper atmosphere research program. The cone installation together with the mountings of pressure gauges is shown in the drawing. In

(Continued on page 60)

THAT SUMMER OF 1816

DAVID M. LUDLUM

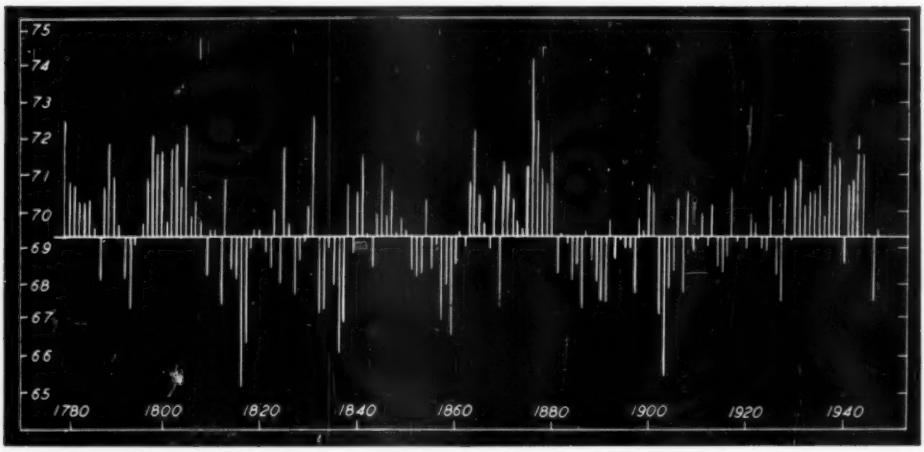
WEATHER PROPHETS representing all shades of the meteorological spectrum have been telling us that the coming summer of 1948 will be cold and wet. The Old Farmer of almanac fame, having already called the turn on the past "old-fashioned" winter, goes on with the dire prediction that the coming months will see a repetition of the famous summer of 1816, known to keepers of weather lore as "the year without a summer," "poverty year," and "eighteen hundred and froze to death." So let's examine the known meteorological facts of 1816 for a preview of what would be in store for us were such predictions to come to pass.

The winter of 1816 had not been unusual, and several months had temperature averages above normal. In April and May, however, cold and wet weather had prevailed over the northeastern states, with damaging frosts retarding plantings in the latter month. Early in June the first general inflow of warm, tropical air penetrated to all parts of the Northeast, raising the hopes of farmers who had seen their plowing and planting go for naught in the frosty nights of May. At Salem, Mass., this June heat wave was climaxed with a reading of 92° F. on June 5th.

That very day, however, a cold front was sweeping southeastward across New England that was to make meteorological and economic history. As the winds shifted into the north and northwest, a cold polar air mass of record severity dropped temperatures abruptly. At Salem the fall was 49 degrees in 24 hours, with a reading of 43 degrees by the next morning. The cold continued for the next four days. At Williamstown, Mass., where reliable records were kept at the college, a 7 a.m. reading of 35° was registered, with the minimum probably at freezing. New Bedford, on the coast, had a low reading of 38°.

For the next four days, June 6-9, there were severe frosts every night from Canada to Virginia except for the immediate seaboard. Snow fell to measurable depth in Ohio and across New York State and northern New England. In Massachusetts snow whitened the ground as close to the sea as Newton. Ice was reported from the suburbs of Philadelphia. Farther north a second snowstorm laid down a white blanket in the hill country of northern Vermont and New Hampshire. The editor of the Danville, Vt., *North Star* gave a moving description:

"Melancholy Weather. . . . Some account was given in the last issue of the unparalleled severity



Summer temperatures (June, July, and August) at New Haven, Conn., from 1780 to 1947, with the year 1795 missing. The mean of 69°.3 F. employed for this station (heavy horizontal line) is that for 1873 to 1923. During the 167-year period the coldest season was 1816 (65°.2), and the warmest was 1876 (74°.2). The coldest single month was June, 1903 (60°.2); warmest, July, 1876 (77°.4). All data taken from *World Weather Records*, H. H. Clayton.

of the weather. It continued without any essential amelioration, from the 6th to the 10th instant — freezing as hard five nights in succession as it usually does in December. On the night of the 6th, water froze an inch thick — and on the night of the 7th and morning of the 8th a kind of sleet or exceeding cold snow fell, attended by high wind, and measured in places where it drifted 18 to 20 inches in depth. Saturday morning the weather was more severe than it generally is during the storms of winter. It was indeed a gloomy and tedious period. The shoots of leaves of forest trees, which were just putting forth, and corn and garden vegetables that were out of the ground, were mostly killed. But it is thought corn will recover from the shock, and that the buds and blossoms are injured very little, if any. Since Monday the weather has been tolerably good; the citizens are recovering their spirits, and the din of industry is again heard." *June 15, 1816.*

Thus the year without a summer made its debut. Throughout the rest of the season each month averaged considerably below normal, and there was a dearth of precipitation. All this points to the dominance of high pressure areas and a flow of cold, dry air. Tem-

(Continued on page 63)

The Tornado Story of 1948

TORNADOES have been in the headlines this spring. Although their frequency of occurrence has not been above normal, several have been noteworthy in destructiveness. Most tornadoes pass through open farm country and cause little property damage or loss of life. Occasionally, however, a tornado crosses a settled community with appalling results. This year, many air fields with their flimsy buildings and valuable planes were a principal target.

Tinker Field, the Air Forces base near Oklahoma City, was visited by twisters twice in one week. At 10:10 p.m., March 20th, strong winds of a tornado nature struck Will Rogers Field. The Weather Bureau anemometer there was clocked at 98 miles per hour, and the barograph made a vertical fall and rise of 0.31 inches. The storm then moved cross-country and reached Tinker Field, a distance of 10 miles, 12 minutes later. Several hundred decommissioned airplanes were stored on the field, and the tornado cut a swath right through the center of the parked planes. Fifty of them were destroyed, and 50 more were damaged — a total loss of 10 million dollars. Further damage of $222,000 was done to buildings and $15,000 to the local utilities system. This was, according to the Weather Bureau, "the greatest property damage from a single tornado ever noted in Oklahoma."

Five days later, on the 25th, another tornado took a short, but equally destructive course across part of Tinker Field. This time 35 planes were destroyed and 49 damaged. Hailstones as large as ¾ of an inch fell and the wind on the edge of the whirl

Tornado occurrences in the first four months of 1948. Based on newspaper accounts and preliminary reports of the United States Weather Bureau.

was recorded at a speed of 78 miles per hour.

A second area that suffered this spring was the Illinois-Indiana sector. On March 19th, widespread windstorms occurred throughout all this area as a cold front with a northeast-southwest orientation moved across the Lakes region. To the south, winds up to 95 miles per hour were reported, and a series of tornadoes broke out. A twister originated in Missouri that afternoon, hopped across the Mississippi River, and caused havoc in the Illinois towns of Fosterburg and Bunker Hill.

Again on the 26th of March, seven states in the Middle West and South reported distinct tornadoes. The greatest property damage was at Danville, Ind., and at Coatesville, west of Indianapolis. Practically the entire business section of Coatesville was leveled. A state-wide campaign to raise funds was very successful, with much of the money contributed by sight-seers who came to view the destruction.

D. C. C.

Lightning strikes the Empire State building, June, 1947. Photograph courtesy of the News, New York's picture newspaper.

LIGHTNING FLASH!

ERIC SLOANE

ILLUSTRATED BY THE AUTHOR

IT ALL HAPPENS in the twinkling of an eye, but what appears to be simply a flash of lightning is really a very complicated series of electrical events, for some of which scientists have not established a complete description. A typical lightning bolt involves the creation of oppositely charged areas, an introductory pilot streamer, a series of rapid surges toward the ground, with a return streamer established as soon as contact is made. The stroke channel thus made may be used over and over again, a score of times in a fraction of a second.

As the storm approaches, sensitive instruments reveal that the electric field at the ground fluctuates according to the charge in the cloud above; point discharge fills the air above the ground with a protecting blanket of charge. Lightning's energy is measured by the change in ground gradient during a stroke; by the current in tall objects when struck; and by surge currents in power systems. Measuring instruments have been placed on fire towers, tall smokestacks, radio towers, and high buildings. No ground stroke has ever been observed initiated by an upward leader, but lofty objects usually start their own lightning. For example, 50 of 52 strokes "hitting" the Empire State building in New York City were initiated by upward leaders.

According to "Lightning Phenomena," a paper by G. C. McCann, Westinghouse Electric and Manufacturing Company, there are six conceivable ways by which a thundercloud may discharge its electricity. These are numbered in the drawing opposite as:

1. Discharges between positive and negative areas within the cloud: sometimes into and through the air beneath the base.

2. Discharges between upper positive and lower negative regions, probably the most frequent lightning inside the cloud.

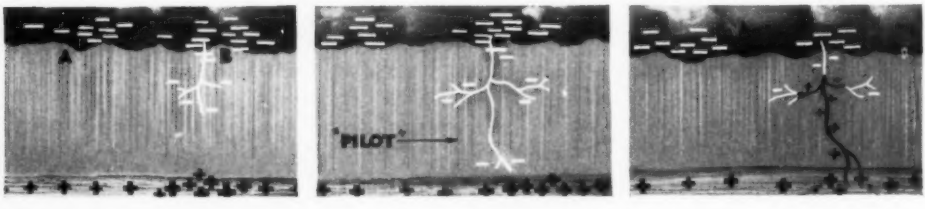
3. A glow discharge into the air near the thundercloud, rather infrequently seen.

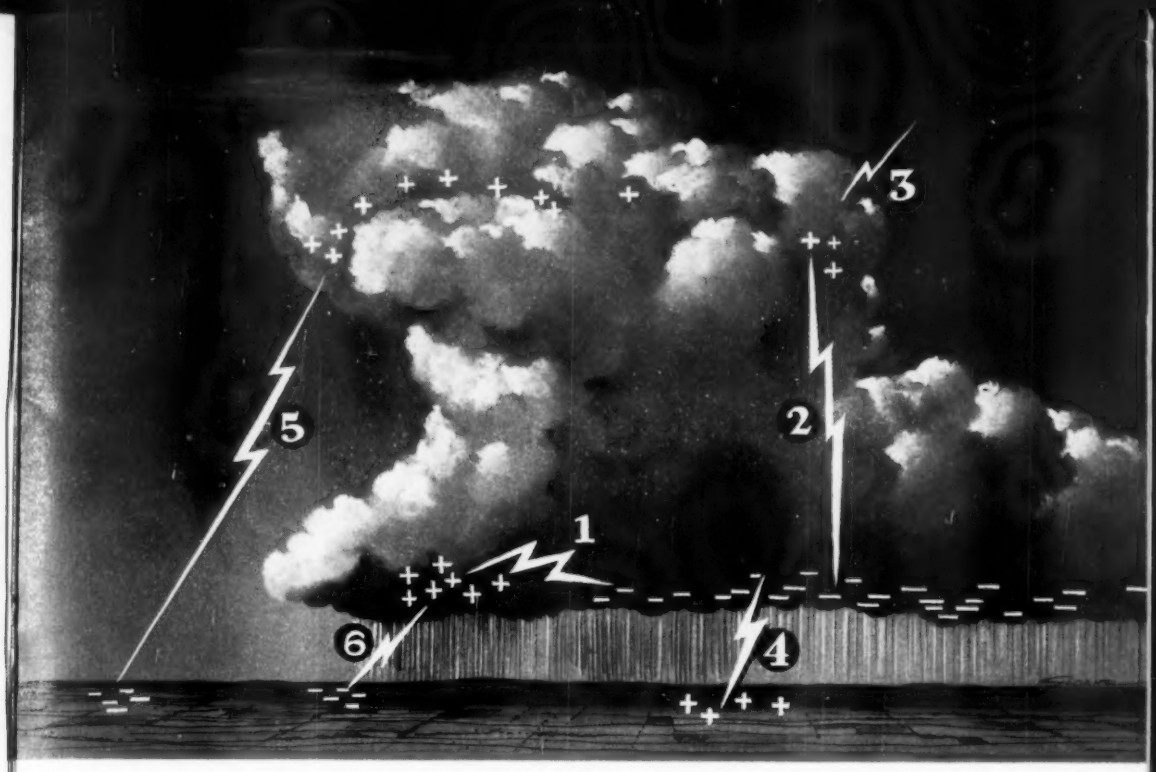
4. Lightning from a negative region in the cloud base to the positively induced charge in *and above* the earth's surface; the sketches below show details of this strike.

5. The swept-up positive charge near the top of the thunderhead very infrequently strikes directly to the earth.

6. A few positive areas in the base of the cloud induce a negative field at the earth, so that occasionally a bolt of this type occurs.

The six drawings below represent, from left to right, the stages in a *leader stroke* (first four sketches) and a second stroke. The downward or leader streamer has a dual nature. By means of a camera invented by Sir Charles Boys, Professor B. F. J. Schonland, Johannesburg, South Africa, has obtained high-speed photographs which show that the leader proceeds earthward in a series of steps, each originating in the cloud and traveling at about 10,000 kilometers per second. (See "The Lightning Discharge," Halley Lecture, de-





livered May 28, 1937, Oxford University.)

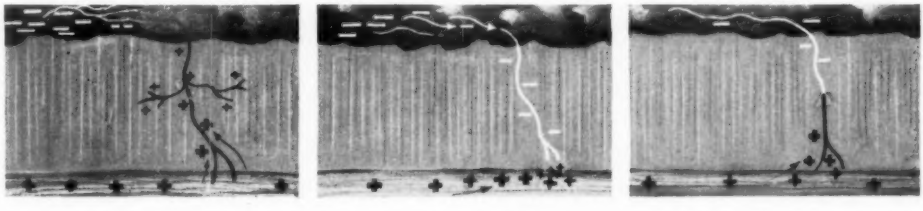
But the actual downward progress of the branching ends of the visible lightning is at about 100 to 300 kilometers per second. Thus, there is believed to be a pilot streamer, only a fraction of an ampere, which clears the way for the successive steps of the leader streamer. Which branch of this pilot finally contacts the ground is determined only at the last instant by the field of objects on the ground.

Instantly upon contact with the ground, the return streamer reaches upward, but on its way it "fills" the branches originally formed by the pilot. Its current is sometimes as much as 160,000 amperes. The return streamer averages 20,000 kilometers per second, taking 0.00004 second from ground to cloud.

The return streamer discharges (passes to the ground) the negative charges in the cloud and branches. Note that the current here is passing from cloud to ground, even though the positive field of the return streamer has moved upward. The nearby nest of charge at *A* sends out feelers, seeking to use the now-established stroke channel.

The next stroke, perhaps 3/100 second after the first, is initiated by a *dart* directly from cloud to ground, using only the main stroke channel. Rarely is it of step character, and rarely does it branch.

The return streamer of the second stroke removes to the ground the charge on the dart leader, to complete the second stroke. By this time, high winds may have slightly altered the shape of the stroke channel. There may be as many as 30 or 40 strokes down the same channel to discharge centers of the cloud four to six kilometers apart.



Amateur Weathermen of America

Amateur Weathermen of America comprises an association of all followers of the ways of the weather. Its purpose is to enlarge our understanding of weather and climate and to apply this information for the greater enjoyment of life. The Amateur Weathermen is an agency for the exchange of information, both technical and popular, among all interested individuals and groups. It is especially concerned with all projects that will enlarge the scientific outlook of the youth of America. All who enjoy studying any aspect of weather phenomena are eligible for membership and participation in its activities. Write to David M. Ludlum, Director, AWA, Franklin Institute, Philadelphia 3, Pa.

THE FIRST SUMMER MEETING of the Amateur Weathermen of America will be held at Mt. Washington, N. H., on Tuesday, July 6, 1948. The theme of the gathering is "Weather and Summer Camping," to demonstrate to camp directors and councillors how weather observing and forecasting may be useful in the camp program.

There will be two sessions: one in the morning from 11:00 a.m. to 12:30 p.m., and another in the afternoon at 2:00 p.m., lasting until 3:30 p.m. These hours are arranged to allow a maximum attendance of camp people. The meeting will be held at the Pinkham Notch Lodge of the Appalachian Mountain Club on Route 16.

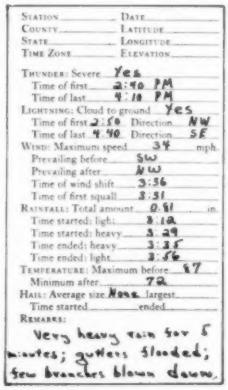
Several prominent meteorologists will be on hand for talks and discussion. Dr. Charles F. Brooks, Harvard University, will tell of his many years experience in forecasting summer weather in New England. Vincent J. Schaefer, General Electric Company, is scheduled to demonstrate his artificial cloud and snow making techniques. A member of the Mt. Washington Observatory staff will describe the work carried on there since 1932, and David M. Ludlum, director, AWA, will outline a summer weather program for camps.

Other events include a demonstration of a rasonde ascent and the release of several tagged pilot balloons. A forecasting contest will enable amateurs to pit their wits against the experts. Movies on weather subjects will be shown before and after the regular sessions. The observatory atop the 6,293-foot peak of Mt. Washington will be open, and AWA members are invited to inspect the facilities.

Accommodations are available for meals and overnight lodging in the valley at the Pinkham Notch Lodge by writing c/o Joseph Dodge, Gorham, N. H. A limited number of accommodations may be available on the summit at the Tip Top House, Mt. Washington, Gorham, N. H. Reservations for overnight should be made as soon as possible by writing directly to the lodge or to Tip Top House.

THUNDERSTORM TRACKING will again be the summertime project of Amateur Weathermen of America. All the meteorological characteristics of the thunderstorm observable from the ground without instruments will be studied. An anemometer and a rain gauge will be helpful but not necessary. Observations are to be recorded on the standard postcard form reproduced here, and mailed to AWA headquarters, where the data will be analyzed and published in the monthly *Weatherwatch*.

Use one form for each distinct storm. Record only those that come within 10 miles of your locality and affect the meteorological conditions in your immediate vicinity. Do not report distant lightning at night (so-called heat lightning). Leave blanks for all missing data, and do not guess or improvise data. A blank space may be of value, and an incorrect entry can only cause confusion. Enter only observations made by you personally; do not enter hearsay. If the time is unknown, state this in your report. For a supply of reporting forms, whether or not you belong


STATION ____ DATE ____
COUNTY ____ LATITUDE ____
STATE ____ LONGITUDE ____
TIME ZONE ____ ELEVATION ____

THUNDER: Severe Yes
Time of first 2:50 PM
Time of last 4:10 PM
LIGHTNING: Cloud to ground Yes
Time of first 2:50 Direction NW
Time of last 4:40 Direction SE
WIND: Maximum speed 34 mph.
Prevailing before SW
Prevailing after NW
Time of wind shift 3:36
Time of first squall 3:51
RAINFALL: Total amount 0.81 in.
Time started: light 3:10
Time started: heavy 3:29
Time ended: heavy 3:35
Time ended: light 3:56
TEMPERATURE: Maximum before 87
Minimum after 72
HAIL: Average size None largest
Time started ____ ended ____
REMARKS:
Very heavy rain for 5 minutes; gutters flooded; few branches blown down.

to the AWA, write Thunder and Lightning, Amateur Weathermen of America, Franklin Institute, Philadelphia 3, Pa.

INSTRUCTIONS FOR FILLING FORM

LATITUDE, LONGITUDE, ELEVATION: Consult town engineer, library, post office, railroad station, or secure U. S. Coast and Geodetic Survey map.

THUNDER: *Severe* — Answer "yes" if 10 seconds or less intervene between flash of lightning and accompanying thunderclap.

Time of first: Local standard time of first thunder heard.

Time of last: Local standard time of last thunder heard.

LIGHTNING: *Cloud to ground* — Answer "yes" if lightning bolt is seen to pass from cloud to ground: do not enter cloud-to-cloud type.

Time of first and *direction:* Local standard time; eight compass points, N, NE, E, SE, S, SW, W, NW. Same for *Time of last.*

WIND: *Maximum speed* in miles per hour with direction to eight compass points, but leave blank if no anemometer is available.

Prevailing before is direction of wind during the hour before the storm.

Prevailing after is direction of wind during the hour after the storm.

Time of wind shift is when the wind definitely shifts and maintains a new direction; usually from S or SW to W, NW, or N.

Time of first squall is the time when the squall line hits and the wind suddenly increases.

RAINFALL: *Total amount* in inches, but do not estimate rainfall amounts. Leave blank if a rain gauge is not available.

Time started: light — when rain commences; *heavy* — when heavier rain (shower type) commences.

Time ended — as above, in reverse order.

HAIL: *Average size* — Use measuring tape and if possible judge average size and also record largest size of newly fallen hailstones only; photograph, if possible.

TEMPERATURE: *Maximum* during the hour preceding storm (before main wind shift).

Minimum during the hour following storm (after main wind shift).

REMARKS: Any attendant meteorological phenomena or physical damage in the locality.

PRIVATE OPINION

The reaction of Abraham Lincoln to the untimely application of Francis L. Capen for a job forecasting the weather was revealed in a recently opened collection of documents. Lincoln commented about Capen on April 25, 1863: "He told me three days ago that it would not rain again till the 30th of April or the 1st of May. It is raining now and has been for 10 hours. I cannot spare any more time to Mr. Capen."

Naval Reserve Billets

VACANCIES still exist in both the organized and volunteer reserve of the Navy's reserve weather program for 1948, in all rates as well as for Apprentice Seamen. As announced in WEATHERWISE for February, 1948, Apprentice Seamen are recruited from nonveterans who are physically qualified and between the ages of 17 and 40 years.

Amateur weathermen and veteran weather personnel who wish to participate in the aerological component of the volunteer reserve are encouraged to contact the nearest naval recruiting station. Those interested in the organized reserve should contact the personnel officer at the nearest Naval Air Reserve training station.

The stations at which training of reserve aerological personnel is being conducted include the Naval Air Reserve Training Units at Anacostia, D. C.; Jacksonville, Fla.; Norfolk, Va.; Seattle, Wash. There are also the Naval Air Stations at Akron, Ohio; Atlanta, Ga.; Columbus, Ohio; Dallas, Tex.; Denver, Colo.; Glenview, Ill.; Grosse Ile, Mich.; Los Alamitos, Calif.; Memphis, Tenn.; Miami, Fla.; Minneapolis, Minn.; New Orleans, La.; New York City (Floyd Bennett Field); Oakland, Calif.; Olathe, Kans.; Squantum, Mass.; St. Louis, Mo.; Willow Grove, Pa.

AMERICAN METEOROLOGICAL SOCIETY NOTES

Through the generosity of an anonymous donor, supplemented by publication funds of the American Meteorological Society, copies of WEATHERWISE have been sent to all members of the society for February, April, and June. It has not yet been determined whether this arrangement will continue for the rest of the year. Your comments on the first three issues of this magazine would be of great assistance to the council of the AMS in determining the society's policy. Address your comments, criticisms, and suggestions to the Executive Secretary, American Meteorological Society, 5 Joy St., Boston 6, Mass.

A meeting of the AMS is scheduled to be held at the University of California, Berkeley, Calif., Wednesday and Thursday, June 23 - 24, 1948. The sessions will be concurrent with those of the Pacific Division, American Association for the Advancement of Science.

An early fall meeting of the society will be held at the Franklin Institute, Philadelphia, Pa. on Friday and Saturday, September 10 - 11, 1948.

A RECENT METEOROLOGICAL ROCKET

(Continued from page 53)

order to cover the range of pressures encountered in flight, two types of sensitive pressure gauges were developed. One of these is an electronic device containing a small quantity of radioactive substance which emits alpha particles. The particles cause ionization of the air within a small chamber. The ionized gases cause a current to flow between two electrodes within the chamber and the current is used as a measure of the density of the air present. The second pressure device, known as a Pirani gauge, makes use of the dependence of heat loss of a hot wire on the pressure of the surrounding air.

In order to obtain information on the degree of large-scale mixing and diffusion rates at great altitudes, the atmosphere was sampled to altitudes of about 50 miles by means of evacuated bottles placed in the midsection of the rocket. The sampling containers developed by the University of Michigan consist of metal bottles surrounded by cages of steel sufficiently rugged to withstand the impact of the rocket landing. These bottles are opened for several seconds while air is scooped into them, and they are then sealed by soldering shut a copper tube near the neck of each bottle. The opening and closing mechanism is activated electrically by a timing motor set to perform the operation at the altitude at which the sample is desired. A number of these sampling bottles have been recovered. Although no analysis has yet been made, it is expected that the ratio of oxygen to helium will be determined by microchemical techniques and by means of the mass spectrograph.

Of importance in interpreting data obtained in these flights (especially the pressure measurement around the cone) is the aspect of the rocket, that is, the position of the axes of the rocket during flight with respect to the line of flight. To determine this aspect, three cameras were mounted in the fins as shown in *D* of the drawing. These cameras take pictures continuously during flight and record the position of the horizon and the sun relative to the rocket.

One of the most important problems which must be solved in rocket-sounding research is that of making available the readings of the instruments during flight. To solve this problem a system of radio-telemetry has been designed by the Naval Research Laboratory. The telemeter translates the instrument readings into coded radio signals. Receiving equipment located on the ground receives, decodes, and records these signals.

It should be emphasized that the data obtained on the April 2nd flight is still being assembled, analyzed, and correlated. On the basis of this information modifications and improvements are being made on the instruments used on this flight. As soon as the techniques for determining pressure, temperature, composition, and wind structure are perfected, it is expected that several similar rocket soundings will be made during selected 24-hour periods at various geographical locations and during the several seasons.

Weather Exchange

Classified advertisements for this column are 8 cents a word, including address; minimum ad 20 words. Remittance must accompany orders. Write Weatherwise, AWA, The Franklin Institute, Phila. 3, Pa.

POSITION WANTED: Available for weather work after May 25th, one graduate Advanced Weather Forecasting Course, Spartan School of Aeronautics. P. O. Box 1492, Pryor, Okla.

WANTED: Balloon theodolite in good condition, Gurley or White. State condition and price. Box 23, Weatherwise.

WANTED: Back file of **Monthly Weather Review** for AWA office, bound volumes preferred. Box 24, Weatherwise.

FOR SALE: Equatorial mountings for Weather Bureau instruments, with motor drive on polar axis such that the instrument follows the sun. Price of mounting for pyrheliometer tube $135.00. Water-vapor spectroscope prices quoted on request. C. C. Young, 25 Richard Road, East Hartford 8, Conn.

FOR SALE: Friez triple register to record wind direction and speed, duration of sunshine, and duration and amount of rainfall. Excellent condition. Best offer accepted. Box 21, Weatherwise.

FOR SALE: Standard Weather Bureau rain gauge, complete, excellent condition, copper and brass construction. Best offer. Woodwind, Rydal, Pa.

LETTERS TO THE EDITOR

(Continued from page 46)

counterclockwise and inward. Even with this curve, when the winds were plotted, it turned out that we had a west-northwest wind of 140 miles per hour at 1,200 feet mean sea level. One of our airline pilots coming in from St. Louis approached the storm center passing to the south of the funnel, where he estimated the wind to be at least 150 miles per hour within five miles of the storm at 1,500 feet.

A. L. McCUISTION
Spartan School of Aeronautics
Tulsa, Okla.

FLYING the weather map

Thunderstorms

H. B. KASTER

RESEARCH METEOROLOGIST, UNITED AIR LINES

THOUSANDS of pilots have flown through thunderstorms. In general, the experiences and conclusions of Army, Navy, and airline pilots are in good agreement regarding the thunderstorm characteristics which should be allowed for in flight planning and when conducting flights in the vicinity of thunderstorms. The cause or theory of thunderstorm processes is, of course, a different subject.

So far as the private pilot in a light airplane is concerned, the best policy on thunderstorm flying is to "keep away from all of them." The transport pilot, experienced in instrument flying, and equipped with a multi-motored all-metal airplane, analyzes the problem in more detail. This difference in viewpoints is similar to that between the opinions of the operator of a light yacht and the captain of an ocean liner regarding a storm at sea. Differences in equipment and experience make different policies advisable.

Turbulence is one of the major problems. Strong updrafts adjacent to downdrafts, with turbulent air between, may not only make control impossible but can subject an airplane to stresses beyond its designed strength. The question of how severe turbulence may become within a thunderstorm can be answered correctly by pointing out that it can be anything up to that of a severe tornado, since a tornado is an outgrowth from a severe thunderstorm. It has been observed that tornadoes frequently occur in groups, and for this reason instrument flying, or flying under conditions of poor visibility, is not advisable in areas where a tornado has been reported.

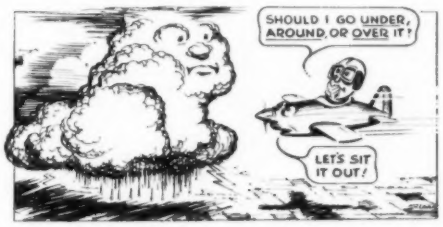
An important characteristic of thunderstorms is the fact that they rapidly pass through a rather definite life cycle. A report indicating severe turbulence generally indicates that a flight an hour or two later will find relatively smooth flying.

Updrafts and turbulence tend to be most severe when the thunderstorm is growing and the cloud outline is sharp with a boiling appearance. As the cloud starts to flatten out to form the anvil top, the heaviest precipitation generally falls, vertical currents and turbulence rapidly decrease, and the surface of the cloud becomes fuzzy in appearance. Because of the tendency to rapid change in conditions as well as because of the rather limited area covered by thunderstorm cells, two flights through the same area and less than half an hour apart often experience widely different conditions.

Downdrafts are not a serious problem except in mountainous terrain, but the downdraft sometimes extends to the ground and blows outward to form a strong gusty "squall wind" just ahead of the thunderstorm. Squall winds have overturned and wrecked parked airplanes which were not fastened down. Take-off or landing in the vicinity of a thunderstorm is avoided for obvious reasons.

The air is smooth under some types of thunderstorms, but turbulence often extends to the ground in other cases, as will be discussed later. In general, the air is becoming unstable in advance of a thunderstorm, but has become stabilized and colder in the rear. Hail may fall out of an overhanging top in front of the storm. For these reasons, it is common practice to detour to the rear of a thunderstorm rather than to pass close in front.

Large hailstones can damage airplanes parked on the ground but are even more serious when encountered in flight. In the northern half of the United States and east of the Rocky Mountains, approximately one storm in 800 produces hailstones as large as walnuts and about one storm in 5,000 produces hailstones as large as baseballs. The large stones are generally few and scattered throughout a fall of smaller stones. Thunderstorms producing large hailstones generally have unusually low bases, and the lapse rate in the surrounding atmosphere is generally steeper than usual, approaching 5° F. per 1,000 feet. Flight through such a shower results in broken windows and battered leading edges of wings and control surfaces, and requires expensive repairs. A considerable number of aircraft encounters with large hail have occurred while flying in the clear beside a thunderstorm but under an overhanging portion. For this reason experienced pilots make an effort to keep blue sky above when close to thunderstorms.



Drawing by Eric Sloane

Radio static is often severe in the vicinity of thunderstorms and may make radio navigational aids difficult to follow.

Icing of aircraft can be very rapid in the tops of growing thunderstorm clouds even in midsummer. This may also be true of a fully grown

thunderstorm, but few pilots have investigated this matter since the top of a mature storm may be well over 40,000 feet above sea level.

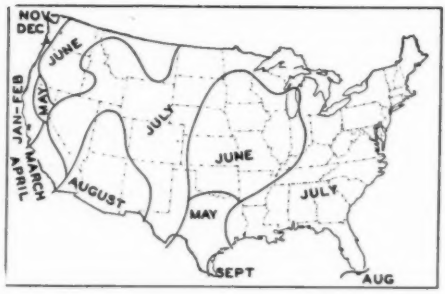
A lightning strike is a possibility in a thunderstorm. There is apparently no difference between the effects of true lightning strikes and the effects of the "static discharges" which are frequently experienced by aircraft flying in cumulus-type clouds in spring and fall. In either case, an all-metal airplane provides excellent protection for anyone inside. Pilots guard against being temporarily blinded by the flash. The usual result is a few holes, sometimes as large in diameter as a lead pencil, burned on a wing tip, nose, or trailing edge of a tail surface. Static discharges which, as mentioned above, resemble lightning strikes in their effects, occur when the airplane is within a cumulus cloud or a thunderstorm cloud with precipitation falling and a temperature within 10° of freezing either above or below. Prior to a discharge, radio static increases rapidly, a brush discharge of "St. Elmo's fire" is visible if at night, turbulence increases, and a strike occurs all within about a minute. Such discharges are often avoided by reducing air speed as the charging rate appears to vary as the cube of the air speed.

When thunderstorms of the type known as convective, thermal, local, or heat-type occur, they can generally be detoured during the early afternoon. If such thunderstorms become numerous, their bases may merge later in the day or they may be joined by a layer of stratocumulus. Below the bases, turbulence is unpleasant but differs little from the usual turbulence due to summer convection currents at low levels. Instrument flight through the lower few thousand feet of the thunderstorm cloud itself is generally no worse. The most severe vertical currents have usually been found at higher altitudes, at 10,000 feet for instance, and during the period of greatest activity.

Under these conditions, the first choice for long-range flights is to fly high and detour the tops. At an altitude of 12,000 feet or higher, the flight will generally be in smooth air while outside of clouds. If the reaching of a high altitude requires a climb on instruments through a thunderstorm layer or the tops are thought to be fairly well merged, the next choice is flight below the base where it is possible to see and detour the centers of activity marked by lightning and heavy precipitation. An experienced pilot can fly below an extensive area of thunderstorms and, by slight changes in course, detour these centers or convective cells.

Orographic thunderstorms form over mountains, usually only when the slopes are heated, and they are similar to convective or thermal thunderstorms.

Advective thunderstorms result from advection of cold air aloft, or warm air at low levels causing instability. This may occur at any time. In the daytime the resulting thunderstorms are often mistaken for normal convective types. However, at night they are referred to as nocturnal thunderstorms. Bases tend to be high and flight below the bases is generally in smooth air. These thunderstorms are common over the Mississippi Valley when Gulf air heated over the southern states during the afternoon reaches the central Mississippi Valley region at low levels late at night.



Months of maximum average number of thunderstorm days. From *Hydrometeorological Report No. 5*, a study of thunderstorm rainfall.

Warm front thunderstorms occur when a convectively unstable air mass moves up a warm front slope. Relatively smooth flying in the clear is found below the frontal surface, but above any lower layer of scud.

Cold front thunderstorms often form a solid line which is sometimes referred to as a squall line. Flight is generally through breaks in the line or between tops. Turbulence is often severe below bases and the active period continues for a long time as the front continues to move into a fresh area of warm moist air.

Pre-cold frontal squall lines or "pre-frontal squall lines" often develop during the daytime several hundred miles ahead of a cold front. These pre-frontal squall lines provide the most severe type of thunderstorm. During their active stage, the following cold front weakens, but it intensifies again when the pre-frontal squall line dissipates during the evening. In its most active period, this type of squall line may provide no breaks between tops and turbulence may become too severe for flight below bases. Pre-frontal squall lines are very difficult to forecast and even their cause is uncertain, although various theories have been advanced. In their early stages they can easily be mistaken for scattered thunderstorms.

Pilots frequently comment upon the misleading appearances of thunderstorms. An innocent looking little storm, possibly just growing into its active stage, may provide severe turbulence. Yet a plane flying through a huge dark cloud with heavy precipitation below may encounter very smooth flying conditions.

THAT SUMMER OF 1816

(Continued from page 55)

peratures throughout New England ran three to five degrees below normal in June and July and about two degrees below in August. April and May had been subnormal, and so were the September and October which followed. At Williamstown, Mass., the weather observer recorded frosts in every month of the year.

Official Weather Bureau climatological reports, published since 1891, show that in the past 57 years the following absolute minima have been recorded in New England: June, 20°; July, 29°; August, 24°. No snow has been reported except on mountain peaks such as Mt. Washington. In the nearby Adirondack Mountains of New York, observers have seen traces of snow 10 times in June and twice in both July and August.

Snowfall records for this period show that the latest heavy fall came on May 20, 1898, when the Vermont uplands were covered by a 10-inch fall. As recently as 1945, a May 11th storm deposited a 15-inch cover. There is nothing in modern records, however, to rival either the snowstorm of June, 1816, or the prolonged period of subnormal temperatures from April to September of that year. Clearly, there must have been a special sequence of meteorological events in operation at this time.

Professor W. I. Milham, Williams College, once probed into the causes of abnormality of weather occurrences such as that of 1816.* He listed five possible causes: 1. Presence of volcanic dust in the atmosphere. 2. Changes in solar activity and the output of solar radiation to the earth. 3. Variations in the surface temperatures of oceans caused by shifting currents. 4. Changes in the physical composition of the upper atmosphere. 5. Accidental causes.

All of these causes of abnormality have been suggested and discussed in recent months by the group of meteorologists who have been investigating the possibilities of controlling the weather processes. Perhaps man in the future will be able to control the elements that brought economic misery to the inhabitants of New England in that summer of 1816.

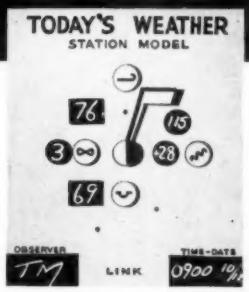
W. I. Milham, The Causes of Abnormality, **Monthly Weather Review**, Vol. 52, No. 12, 563-570, 1924.

Here's a chance for every amateur weatherman to add to the accuracy of his hobby! WINDIKATOR—a *precision-built*, pocket-size anemometer—gives exact wind direction, wind velocity at a glance!

Non-magnetic, rust and corrosion resistant, WINDIKATOR is guaranteed accurate. Leather belt carrying case available. Model A indicates velocity 5-30 MPH, Model B, 10-60 MPH. If your dealer can't supply you, write Dep't. W-6 . . .

The H. M. SAWYER & SON CO.
Cambridge, Massachusetts

WEATHER STATION MODEL



Enlarged masonite replica of station model used on weather maps. Selection of symbols makes it possible to indicate all weather conditions. Specially valuable in teaching weather map reading, consumer weather service, weather theories, weather observations.

Height 17 in., width 15 in., weight 3 lbs., 4 oz.

PRICE: $9.37 (30% discount to non-profit institutions)

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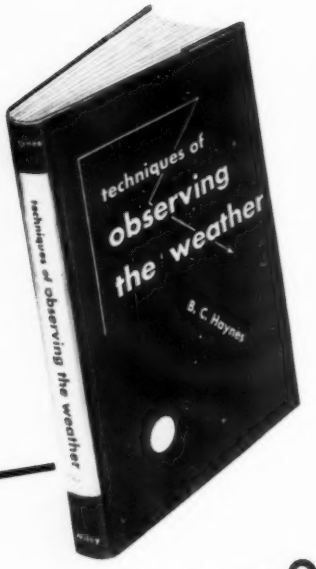

How to collect accurate weather data

TECHNIQUES OF OBSERVING THE WEATHER

By BENARTHUR C. HAYNES

Chief, Observation Section,
U. S. Weather Bureau

A practical book that tells you exactly how to gather the data that is necessary for predicting the weather. The author treats means and methods of observation thoroughly, and gives detailed instructions on the use of instruments, charts and forms.

Technical details are explained simply and clearly. Sections that require exact definitions follow the official international wording used by the United States Weather Bureau.

Contents include: The Atmosphere; The Weather Observatory; Clouds; Visibility; Hydrometers; Temperature; Humidity; Wind; Pressure; Precipitation; Winds-Aloft Observation; Electronic Meteorological Observations; An Improvised Weather Station.

1947 **272 pages** **$4.00**

Copies obtainable on approval.

JOHN WILEY & SONS, INC.
440 Fourth Ave., New York 16, N. Y.

CAUSES OF CATASTROPHE

L. Don Leet. Whittlesey House, New York, 1948. 232 pages. $3.00.

ALTHOUGH nature is generally thought of and written about as a thing of beauty, the full significance of its tremendous power is never more evident than in disasters, the tragedies known as "acts of God," the cataclysms which take a more terrific toll than do the worst of man's devices. These carry such dramatic punch that they play crucial roles in many pieces of the world's great literature, yet Don Leet's book is, to my knowledge, the first to study the causes of catastrophe from a catastrophic point of view. In this little volume there is a wealth of sound science, and it will be an unthinking reader who does not nod an awed acknowledgment both to the forces that Dr. Leet has explained and to the ease and simplicity of his writing.

Dr. Leet is one of the world's top seismologists, and it is not surprising that to him the prime causes of catastrophe are the fiery belches of volcanoes, the shakes and shivers, the quakes and quivers of the globe on which we live. His major interest, therefore, is geological and seismological, with full awareness that disturbances of the solid part of our spinning sphere are attended by companion disturbances in the water and air spheres on and above the surface.

It is the air in which WEATHERWISE readers are principally interested, and Dr. Leet tells the story of hurricanes in some detail, emphasizing not only the drama of their behavior but the inexorable logic of their formation. There is nothing he tells that will be all news to the weather-minded, but his story will help others to understand a little better than ever before the reasons for the terror of the typhoon.

There is one omission from Dr. Leet's book which disturbs me. There is no more violent phenomenon in all of nature's bag of tricks than the tornado. No catastrophe is so positive, so irresistible, so utterly beyond the ability of man to forecast, to prepare for or to outwit, and none wreaks greater havoc where it strikes. Yet there is not even an indirect mention of the fact that these whirling destroyers exist. Yet no one who has ever seen a twister in action would fail to nominate it as a catastrophe.

Since weather is the product of many forces, meteorological and otherwise, it will profit the weatherwise to make the acquaintance of some of them. This book will broaden the awareness of every reader who recognizes the significance of natural phenomena that happen in, on, and above the earth.

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How to Construct a Wind Vane

ONE OF THE OLDEST weather instruments, and one of the commonest, is the wind vane. Its construction can be simple or complicated. Dimension and design may vary, the tail in particular lending itself to a variety of patterns.

The wind vane described here, while fairly easy to build, is both sensitive and durable. Its tail can be constructed of sheet aluminum, galvanized iron or other sheet metal. It is 8″ long and 6″ high. The shaft, with tail on one end and pointer (counterweight) on the other, is 12″ long.

The counterweight is made by pouring hot lead into a form made of sheet metal shaped into a cone. Or you can saw a piece of lead into an arrowhead shape. If the pointer is made by the first method, the end of the shaft should be inserted in the form before pouring in the hot lead. The weight of the pointer is not too important. The means of balancing it with the tail will be given later.

The drawing shows the method of constructing the vane bearing. A 5″ length of ¼″ metal pipe forms the bearing housing. Its lower end is threaded with pipe threads. You may use a standard ¼″ pipe nipple (6″ long) and cut the extra inch off with a hack saw. Pipe of this size is actually about ⅜″ inside diameter, which allows ample room for the vertical vane spindle and its bearing. The lower end of this five inches of pipe should be plugged with a piece of ⅜″ steel shafting or drill rod, ½″ long. Heat the pipe after the plug is inserted in the lower end, as shown in the drawing, and use a little solder to seal it. This makes it oil tight.

The upright spindle supporting the vane, and on which it rotates, may be a piece of ¼″ shafting, or better, of drill rod 5″ in length. The lower end should be rounded off with a file, then smoothed with crocus cloth. Or the rounding process may be done with a lathe if you have access to one. Weight of the vane is then supported by the rounded end of this steel spindle resting on the steel plug, forming an almost frictionless bearing.

The upper end of the 5″ length of pipe is fitted with a brass bushing, ¼″ inside diameter and ½″ in length. You may use a piece of ¼″ inside diameter brass tubing and ⅜″ outside diameter, but you may have to do some filing to get it to fit tightly into the end of the pipe.

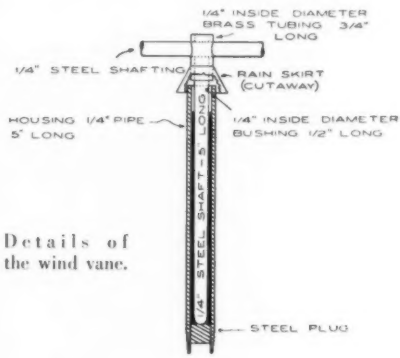
A second piece of ¼″ inside diameter brass tubing is used to fasten the horizontal staff to the top of the steel spindle. The outside diameter of this piece of tubing is not critical, but the piece should be about ¾″ long. Drill a ¼″ hole perpendicularly through the tubing near the top.

Into this hole goes the tail shaft. But before inserting it, split the shaft on the end opposite the pointer with a hack saw, making a cut about 3″ in length. After introducing the shaft through the hole, the tail is slipped into the cut and soldered, riveted, or fastened with small bolts.

The vertical spindle and horizontal shaft are now ready to be soldered into the ¾″ length of brass tubing. But first assemble them, pushing the horizontal shaft back and forth until it balances. The parts should fit fairly tight, so they will remain that way while you heat the brass tubing and apply solder.

A small cone may be shaped out of sheet metal and soldered to the brass tubing in the manner shown. It will keep rain out of the bearing.

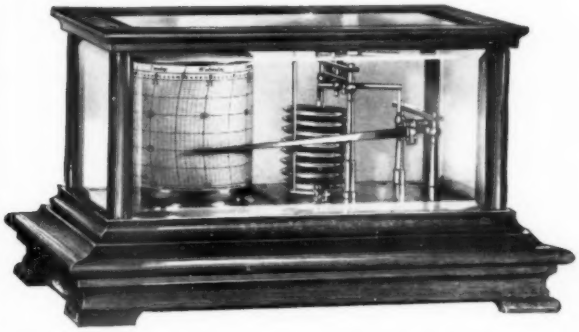
You may use a standard reducer coupling (in this case, an "increaser" coupling) at the lower


1/4" INSIDE DIAMETER BRASS TUBING 3/4" LONG
1/4" STEEL SHAFTING
RAIN SKIRT (CUTAWAY)
HOUSING 1/4" PIPE 5" LONG
1/4" INSIDE DIAMETER BUSHING 1/2" LONG
1/4" STEEL SHAFT - 5" LONG
STEEL PLUG

Details of the wind vane.

end of the pipe to join it to a piece of 1″ pipe which acts as a support. The pipe may be of any reasonable length. Its lower end can be screwed into a standard floor flange for convenience in mounting the wind vane on roof or pole.

Before putting the vane into use, a little light machine oil should be poured into the 5″ length of pipe forming the vane bearing. The bearing should be cleaned out and re-oiled about twice a year.



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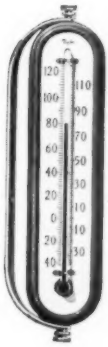

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